REMARKS

Claims 1-3, 5-13, 15-23, and 25-28 are pending.

Claims 1, 12, 13, and 21 are rejected under 35 U.S.C. § 103(a) as being unpatentable over JP 3093695 ("JP '695") in view of Takahiro (JP 03-075298). Applicants traverse.

The Office Action asserts that JP '695 teaches a method of growing a diamond structure. The Office Action states that on a substrate, a layer of diamond nucleation sites is prepared. The Examiner contends that the sites are orientated the same for the vapor growth. The Examiner opines that a layer of polycrystalline diamond is grown on the nucleation sites and the nucleation sites can be diamond in the JP '695 reference. The Examiner concludes that the orientation is of the polycrystalline layer. In the Response to Arguments section, the Examiner indicates that he does not see where in JP '695 teaches that the grown polycrystal is considered to be highly oriented. The Examiner acknowledges that JP '695 states that the diamond is high quality but does not use the phrase "highly oriented." The Examiner requests that the Applicants support their position.

The Applicants attach hereto a partial English translation of JP '695 as Appendix A. Indeed, JP '695 states on page 6 of 10, at lines 4-9:

> That is, the present invention is related to a polycrystalline diamond characterized in that when the intensity of diffraction line of (1,1,1) crystal plane by X-ray diffractometry is 100, the intensity of diffraction line of ***(4,0,0) crystal plane is 20 or more, and that (4,0,0) plane is oriented against the growing substrate plane*** (*emphasis added*).

Thus, JP '695 describes a method of preparing a "**<u>highly oriented</u>**" (*e.g.*, 4,0,0 orientation) polycrystalline diamond on a monocrystalline substrate. In JP '695, elements such as Si, Mo and SiC are used for the monocrystalline substrate (pg. 8, line 3). In the process of preparing the highly oriented polycrystalline diamond, the monocrystalline substrate having a (1,0,0) crystal plane is subjected to vapor phase synthesis for diamond growth. A diamond layer is formed in

the process. Indeed, in this process, the diamond is grown on a substrate made of Si, Mo or SiC, and there is **no teaching of growing the crystal on a diamond substrate**. The diamond layer consists of a plurality of diamond crystal grains having (1,0,0) orientation only.

The next step includes subjecting crystal grains in the diamond layer having *other* than (1,0,0) orientation ("non-(1,0,0) grains") to heating under oxygen or water vapor, dipping into molten-salt of KNO_3, or the like, in order to selectively eliminate the non-(1,0,0) crystals from the diamond layer, such that the crystallinity is poor with less resistance against oxidation than (1,0,0) crystal grains (*see,* pg. 8, line 19 – pg. 9, line 12). The remaining (1,0,0) diamond crystals serve as nucleation cites for the successive chemical vapor growth of diamond (*see*, pg. 9, lines 13-17 and Fig. 3).

The diamond crystals further grown on the substrate with the (1,0,0) diamond crystals as nucleation cites thereof are ***highly oriented*** having 120 strength of diffraction line of (4,0,0) when strength of diffraction line of (1,1,1) by X ray diffraction is 100 (*see,* pg. 9, lines 18-27). This clearly indicates that the product of JP '695 is an aggregate of ***highly oriented*** single crystal diamonds. Even though the title of JP '695 is "Polycrystalline Diamond and the Method of Same," the term "polycrystal" in JP '695 and in the present application are *different* in that the "polycrystal" in JP '695 is merely an aggregate of small-sized single crystal diamond grains having a ***high orientation***. On the other hand, an aspect of the instant application includes polycrystals made of **randomly oriented monocrystals**.

JP '695 describes preparing an aggregate of ***highly oriented*** single crystal diamonds where the diamond grains are grown so that their orientation are aligned with respect to the uniformly oriented nucleation seed diamond grains. In contrast, the instant application grows randomly-oriented polycrystalline diamond on monocrystalline diamond substrate. Thus, highly oriented

single crystal diamonds of JP '695 are considerably different from the claimed diamond polycrystalline film in preparation and structure.

Further, the diamond layer grown on the (1,0,0) monocrystalline diamonds is highly oriented in JP '695. Fig. 4 of JP '695 shows the grown diamond having a strong diffraction line of (4,0,0). JP '695 states on pg. 8, lines 14-17:

> The inventors of the present invention have reached the present invention while studying epitaxially-grown diamond on a single crystal artificial diamond by vapor-phase synthesis.

According to the claimed subject matter per claims 1, 12, and 21, the polycrystalline diamond film has randomly oriented diamond crystals. However, JP '695 does not disclose or remotely suggest the present claimed limitation.

The Office Action acknowledges that the difference between the instant claims and the prior art is that the nucleation sites are single crystal diamonds placed next to each other. The Office Action relies on Takahiro in an attempt to cure the admitted deficiencies of JP '695. The Examiner opines that Takahiro teaches that large single crystal diamonds can be placed together to create a base for diamond growth. The Examiner contends that it would have been obvious to one of ordinary skill in the art to modify JP '695 with Takahiro to use a single crystal diamond base in order to ensure that the grown vapor layer of diamond has uniform orientation.

In the Response to Arguments section, the Examiner opines that Takahiro is relied upon solely to show the use of a monocrystalline diamond substrate.

Takahiro describes using a plurality of monocrystalline diamond as a substrate to form a O/D-grown monocrystalline diamond layer thereon. Although not relied upon to do so, Takahiro does not disclose or suggest, growing a randomly oriented polycrystalline diamond layer. It is well known by persons skilled in the art that if no special controlling conditions are applied, polycrystalline with a specific orientation is normally formed in gas phase growth process and a

polycrystalline diamond consisting of diamond grain crystals having random orientation on and throughout the entire face of the substrate is <u>not</u> present. An aspect of the present subject matter includes growing ***randomly-oriented polycrystalline diamond film on a monocrystalline diamond substrate*** to join a plurality of monocrystalline diamond substrates. Thereby, as taught in the instant specification, growing randomly-oriented polycrystalline diamond film on a monocrystalline diamond substrate requires special treatments or controlling conditions (*see, e.g.,* Para. [0055] and Table 1 of the originally filed specification).

The Examiner opines that the nucleation sites of JP '695 can be replaced by the plurality of monocrystalline diamond substrates to grow a polycrystalline diamond thereon. As previously asserted, JP '695 <u>only</u> discusses growing ***highly-oriented*** polycrystalline diamond that is merely an aggregate of a plurality of diamond crystal grains having the ***same (1,0,0) crystal plane*** on top of the nucleation sites, <u>not</u> ***randomly-oriented*** polycrystalline diamond that is formed on the diamond ***monocrystalline substrate***, as required by claims 1, 12, and 21.

Further, JP '695 states on page 2, lines 10-13:

> It is extremely difficult to manufacture single crystalline diamond having ***an area more than several millimeters on a side*** for electric devices and/or single crystalline diamond having a excellent transparency for optic devices (*emphasis added*).

The use of large-area monocrystalline diamond as a substrate for growing diamond layer is <u>excluded</u> in JP '695. Therefore, one of skill in this art would ***not*** have been motivated to use a monocrystalline diamond plate as a substrate for growing the diamond layer in JP '695.

Takahiro *only* discloses manufacturing a large-area monocrystalline diamond, <u>not</u> a large-area polycrystalline diamond layer, as required by claims 1, 12, and 21. Takahiro fails to disclose or suggest a polycrystalline diamond layer, as required by claims 1, 12, and 21. Although Takahiro discusses a monocrystalline diamond substrate, one of ordinary skill in the art

at the time the invention was made would <u>not</u> be motivated to employ the monocrystalline diamond substrate for growing a randomly-oriented polycrystalline diamond layer.

Obviousness can be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either explicitly or implicitly in the references themselves or in the knowledge readily available to one of ordinary skill in the art. *In re Kotzab*, 217 F.3d 1365, 1370 55 USPQ2d 1313, 1317 (Fed. Cir. 2000); *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988); *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992). There is no suggestion in JP '695 to modify a ***highly oriented*** diamond polycrystalline film to have crystals with **<u>random orientation</u>** or to employ a monocrystalline diamond substrate for growing randomly-oriented polycrystalline diamond, nor does common sense dictate the Examiner-asserted modifications. The Examiner has not provided any evidence that there would be any obvious benefit in making the asserted modification of JP '695. *See KSR Int'l Co. v. Teleflex, Inc.*, 127 S.Ct. 1727, 82 USPQ2d 1385 (2007).

The only teaching of the claimed diamond polycrystalline film having crystals with random orientation is found in Applicants' disclosure. However, the teaching or suggestion to make a claimed combination and the reasonable expectation of success must not be based on applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

As JP '695 and Takahiro do not disclose the same diamond composite substrate and method for manufacturing a diamond composite substrate as disclosed by the present inventors, and even if combined still fail to disclose or suggest the elements recited by claims 1, 12, and 21, the combination of JP '695 and Takahiro does not render the diamond composite substrate and

method for manufacturing a diamond composite substrate as recited by amended claims 1, 12, and 21 obvious.

Claims 2, 3, 5-11, 15-20, 22, 23 and 25-28 are rejected under 35 U.S.C. § 103(a) as being unpatentable over JP '695 in view of JP 03-075298 to Takahiro.

The Office Action acknowledges that JP '695 and Takahiro differ from the instant claims in the dimensions of the layers and orientations. The Office Action contends that in the absence of unexpected results it would have been obvious to one of ordinary skill in the art to determine through routine experimentation the optimum, operable dimensions and dimensions and orientation in the combined references in order to create a uniform layer of diamond improving the properties. In the Response to Arguments section, the Examiner concludes that the claims are not limited in scope to any particular process parameters that the Applicants argue that are critical to growth on a monocrystalline substrate.

Dependent claims 2, 3, 5-11, 15-20, 22, 23, and 25 are allowable for at least the same reasons as their respective base claim, and further distinguish the claimed diamond composite substrate and method to make diamond composite substrate.

The Examiner's "absence of unexpected results" approach in attempting to establish a prima facie case of obviousness denies Applicants' their right to procedural due process of law. This is because there is absolutely no burden upon Applicants to even offer an argument, let alone the proffer evidence of unexpected results, until such time as the Examiner has discharged his burden of establishing a prima facie case of obviousness, **which the Examiner has not done**. *In re Deuel, 51 F.3d 1552, 34 USPQ2d 1210 (Fed. Cir. 1995); In re Rijckaert, 9 F.3d 1531, 28 USPQ2d 1955 (Fed. Cir. 1993); In re Oetiker, 977 F.2d 1443, 24 USPQ2d 1443 (Fed. Cir. 1992).*

Further, the Examiner failed to provide requisite factual basis to support the motivation element, noting that the claimed diamond monocrystalline substrate and diamond polycrystalline film is functionally significant.

The only teaching of the **claimed diamond polycrystalline film having crystals with random orientation is** found in Applicants' disclosure. However, the teaching or suggestion to make a claimed combination and the reasonable expectation of success must both be found in the cited reference, and not based on the Applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991). The Examiner's retrospective assessment of the claimed invention and use of unsupported conclusory statements are not legally sufficient to generate a case of *prima facie* obviousness. The motivation for modifying the prior art must come from the prior art and must be based on facts. The Examiner is not free to ignore the judicial requirement for **facts**. To do so is legal error. *In re Lee,* 277 F.3d 1338 (Fed. Cir. 2002). Apparently, the Examiner has relied on improper hindsight reasoning in reaching the conclusion of obviousness.

Thereby as taught in the instant specification, the resultant diamond composite substrate exhibits an increase in bending resistance (*see, e.g.,* Tables 2 and 4; Paras. [0056]-[0063] of the originally filed specification). However, the cited references do not disclose or suggest this, and apparently are unaware of the unexpected improvement in **both** high toughness and high thermal conductivity. Neither JP '695 nor Takahiro, individually or combined, disclose or suggest growing polycrystalline diamond having crystals with random orientation on a diamond monocrystalline substrate, as required by claims 1, 12, and 21.

Withdrawal of the foregoing rejections is respectfully requested.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper,

including extension of time fees, to Deposit Account 500417 and please credit any excess fees to such deposit account.

Respectfully submitted,

McDERMOTT WILL & EMERY LLP

Lisa A. Kilday
Registration No. 56,210

600 13th Street, N.W.
Washington, DC 20005-3096
Phone: 202.756.8000 BKS:LAK:lnm
Facsimile: 202.756.8087
Date: November 3, 2008

Please recognize our Customer No. 20277 as our correspondence address.

APPENDIX A

Application No.: 10/510,848

Examiner: Robert M. Kunemund

Partial Translation of JP 3093695

(translation begins at p.542, upper right column, line 14)

Means to solve the problem

The inventors of the present invention have reached the present invention while studying epitaxially-grown diamond on a single crystal artificial diamond by vapor-phase synthesis.

That is, the present invention is related to a polycrystalline diamond characterized in that when the intensity of diffraction line of (1,1,1) crystal plane by X-ray diffractometry is 100, the intensity of diffraction line of (4,0,0) crystal plane is 20 or more, and that (4,0,0) crystal plane is oriented against the growing substrate plane.

In addition, as a method to realize the afore-mentioned polycrystalline diamond, the present invention provides the production method of a polycrystalline diamond that is characterized in that in a polycrystalline diamond layer grown on the substrate by vapor-phase synthesis, leaving only diamond crystal grains whose (1,0,0) crystal plane is parallel to the substrate intact, removing diamond grains having other orientations, and then afterward, further growing diamond by vapor-phase synthesis on the said substrate.

For the method in the present invention of leaving only diamond crystal grains whose (1,0,0) crystal plane is parallel to the substrate intact, removing diamond grains having other orientations from a polycrystalline diamond layer grown on the substrate by vapor-phase synthesis, and then afterward, further growing diamond by vapor-phase synthesis on the said substrate, it is especially preferable to adopt such methods as heating under the presence of oxygen or water vapor, dipping into molten salt, or placing plasmas comprising oxygen and/or water vapor.

operation of the invention

The method of producing the polycrystalline diamond of the present invention is provided first.

The inventors of the present invention, after repeated studies of epitaxially growing diamond by vapor-phase synthesis with monocrystalline artificial diamond as a substrate, have found that extremely high-quality diamond layer can grow on (1,0,0) crystal plane.

Further study revealed that even in growing polycrystalline diamond layer by vapor-phase synthesis on substrates of heterogeneous substances other than diamond, the crystal grains whose (1,0,0) crystal planes are parallel to the substrate show an extremely better crystallinity than other crystal grains.

However, in the conventional vapor-phase synthesis, although diamond films having (1,0,0) orientation to some extent has been obtained, diamond films having as good enough quality as that having transparency for practical use has not been obtained.

The present invention solves the above-mentioned problem by a novel technique of ceasing the diamond-film growth, removing diamond crystal grains other than those having a orientation of (1,0,0), and then afterward, growing diamond again by vapor-phase synthesis.

For the diamond vapor-phase synthesis of the present invention, any prior-art diamond vapor-phase synthesis can be employed, the example of which includes plasma CVD method, thermal CVD method heating thermal electron emitters, combustion flame method, ion beam method, and laser CVD method.

The substrate for the present invention can be any material that tolerates heat necessary for diamond synthesis. However, for example, such heat-resisting materials as Si, Mo and SiC are the most preferable.

As for conditions for diamond growing on the substrate, conditions where (1,0,0) orientation is easily obtained is preferable. In plasma CVD method or thermal CVD method, the ratio of carbon to hydrogen in the feedstock gas is preferably about 1.5 to 5%. This is because below carbon to hydrogen ratio of 1.5%, diamond crystals are not easily aligned with (1,0,0) crystal plane orientation and diamond growth rate decreases, and over 5%, the total crystallinity becomes deteriorated. It is preferable that gas pressure at the diamond synthesis 30 Torr or more. It is not preferable under 30 Torr, because diamond growth rate is extremely low below the same value.

Fig. 1 represents a model showing the situation where a polycrystalline diamond layer 2 is formed on a substrate 1. Shaded portions are diamond grains having (1,0,0) orientation.

Elimination of diamond grains having orientation other than (1,0,0) crystal plane after synthesizing polycrystalline diamond on the substrate in vapor-phase is preferably conducted at the point in time when the diamond film thickness gets 2μm or more, and before the film thickness gets 100μm at the latest. This is because, each particle is small enough to have unclear orientation when the film thickness is below 2μm, and particles having orientation other than (1,0,0) crystal plane can be eliminated entirely with difficulty when the diamond film thickness is over 100μm.

The method of eliminating particles having orientation other than (1,0,0) crystal plane includes method of heating under the

presence of oxygen and water vapor, dipping into molten salts such as KNO_3, KOH, NaOH, placing in plasma comprising oxygen or water vapor. More specifically, in case of elimination using molten salts, KNO_3 is melted at a temperature of 600 C, and the diamond is dipped into it for 1 hour. In case of heating under the presence of oxygen or water vapor, the diamond is heated at a temperature of over 500 C, for instance 600 C, in the atmosphere where partial pressure of oxygen or water vapor is 10 Torr or more.

polycrystalline diamond having the orientations other than (1,0,0) crystal plane can be eliminated because diamond crystal grains oriented to (1,0,0) crystal plane have better crystallinity than other grains, less affected by erosion by oxidation occurring in diamond or carbon materials.

As shown in Fig. 2, the following step comprises growing diamond layer by vapor-phase synthesis on the substrate 1 having only diamond grains having (1,0,0) crystal plane up to a designated thickness. This way, the grown diamond can have orientation of (1,0,0).

The polycrystalline diamond obtained by the method described above is characterized in that when the intensity of diffraction line of (1,1,1) crystal plane by X-ray diffractometry is 100, the intensity of diffraction line of (4,0,0) crystal plane is 20 or more. According to an X-ray diffraction data of ASTM, diamond powder, which is randomly oriented, has 7 of the intensity of diffraction line at (4,0,0) crystal plane when that for (1,0,0) is 100. Since the afore-mentioned polycrystalline diamond has the intensity of 20, it means that the said polycrystalline diamond has a strong orientation.

(end of translation at p.543, lower right column, line 3)

Translation of Claim 1 of D2

A polycrystalline diamond characterized in that when the intensity of diffraction line of (1,1,1) crystal plane by X-ray diffractometry is 100, the intensity of diffraction line of (4,0,0) crystal plane is 20 or more, and that (4,0,0) crystal plane is oriented against the growing substrate plane.

Very truly yours,

Masami Sakai

Masami SAKAI

Patent attorney